HEAT TRANSFER THROUGH FORCED CONVECTION

Contents

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1. Objective:

Study of convection heat transfer in forced convection

2. Aim:

Comparison of heat transfer coefficient for different air flow rates and heat flow rates. To find surface heat transfer coefficient for a pipe losing heat by forced convection.

3. Introduction:

Convection is defined as defined as process of heat transfer by combined action of heat conduction and mixing motion. Convection heat transfer is further classified as Natural Convection and Forced Convection. If the mixing motion takes place due to density difference cause by temperature gradient, then Natural or Free Convection knows the process of heat transfer as heat transfer. If the mixing motion is induced by Forced Convection knows some external means such a pump or blower then the process as heat transfer.

In many practical situation and equipment we invariably deal with flow of fluids in tubes e.g. boiler, super heater and of a power plant, automobile radiator, water and air heater or coolers etc.

The flow through a tube may be either laminar or turbulent or in transition.

4. Theory:

Air flowing into the heated pipe with very high flow rates the heat transfer rate increase. The temperature taken by the cold air from the bulk the air from the bulk temperature taken by the cold air from the bulk temperature rises and its temperature. Thus, for the tube the total energy added can be expressed in terms of a bulk- Temperature difference by

$$q = mc_p(T_{b2-} T_{b1})$$

Bulk temperature difference in terms of heat transfer coefficient

$$q = hA\ (T_{b1} - T_{b2})$$

5. Description:

The apparatus consists of blower unit with the test pipe. The test section is surrounding by the Nichrome heater. Four temperature sensors are embedded on the test section and two temperature sensors are placed in the air stream at the entrance and exit of the test section. Test pipe is connected to the delivery side of the blower along with the orifice. Input to the heater is given through the dimmer stat and measured by voltmeter & Ammeter. Digital Temperature indicator is provided to measure temperature. Air flow is measured with the help of orifice meter and the water manometer fitted on the board.

6. Utilities Required:

1. Electricity Supply: Single Phase, 220v VAC, 50 Hz, 5-15 Amp Socket with earth connection.

2. Floor Area Required: 1.5m*1.5m

7. Experimental procedure:

Starting procedure:

1. Ensure that Mains ON/OFF switch given on the panel is at OFF position & dimmer stat is at zero position.

2. Connect the electrical supply to the set up.

3. Fill water in manometer up to the scale, by opening PU pipe connection from the air flow pipe and connect pipe back to its position after doing so.

4. Switch ON the Mains ON/OFF switch.

5. Set the heater input by Dimmer stat, voltmeter in the range 40-100 v

6. Switch ON the blower.

7. Set the flow of air by operating the valve.

8. After 1.5 hr note down the reading of voltmeter, ampere meter and temperature sensor in the observation table after every 10 minutes interval till observing change in consecutive readings of temperatures($\pm 0.2^0$C).

Closing Procedure:

1. After experiment is over set the dimmer stat to zero position.
2. Switch OFF the Blower.
3. Switch OFF the Mains ON/OFF switch.
4. Switch OFF electric supply to the set up.

8. Observation & Calculation:

DATA:

$D_i = 0.028\,m$

$D_o = 0.038\,m$

$L = 0.4$ m

$d_o = 0.014\,m$

$d_p = 0.028$ m

$C_p = 1.003\ kj/kg^{o}C$

$\rho_a = 1.205\ kg/\,m^3$

$\rho_w = 1000\ kg/m^3$

$C_o = 0.64$

OBSERVATION TABLE:

S.NO	V volts	I amp	T_1 ^0C	T_2 ^0C	T_3 ^0C	T_4 ^0C	T_5 ^0C	T_6 ^0C	h_1 cm	h_2 cm

CALCULATIONS:

$T_s = (T_2 + T_3 + T_4 + T_5)\,/\,4$, ^0C = ……………^0C

$T_a = (T_1+T_6)/2$, ^0C = ……………^0C

$A = \pi D_i\ L, m^2 = \cdots \ldots \ldots \ldots \ldots . . m^2$

$\Delta H = \{(h_1 - h_2)/100\}(\frac{\rho_w}{\rho_a} - 1)$, m =. . … … … … . . m

$Q = \frac{C_d\ a_p a_o \sqrt{2g\Delta H}}{\sqrt{a_p^2 - a_o^2}}$, $\frac{m^3}{s} = \cdots \ldots \ldots \ldots \ldots \ldots \ldots . \frac{m^3}{s}$

$U = \frac{Q_a}{A(T_s - T_a)}$, $\frac{w}{m^2}$ °C $= \cdots \ldots \ldots \ldots \ldots \ldots \ldots . . \frac{w}{m^2}$ °C

9. Nomenclature:

A = transfer area, m^2

C_p = Specific heat of air, kj/kg°C

C_o = Coefficient of Discharge

D_i = Inner diameter of test section, m

D_o = Outer diameter of test section, m

d_p = Diameter of pipe, m

d_o = Diameter of orifice, m

DH = Heat loss, m of air

I = Ammeter reading, amp

L = Length of test section, m

m = Mass flow rate of air , kg/s

Q_a = Heat taken by air,W

Q = Flow rate of air.m^3/s

$h_1.h_2$ = Manometer readings,cm

T_1 = Air inlet temperature of test section, ^oC

T_2, T_3, T_4, T_5 = Surface temperature of test section, ^oC

T_6 = Air outlet temperature, ^oC

ρ_w = Density of water, kg/m^3

ρ_a = Density of Air, kg/m^3

T_a = Average temperature of Air, ^0C

T_s = Average surface temperature, ^0C

V = Voltmeter reading, volts

U = Heat transfer coefficient .Watt/$m^{2\,0}C$

10. Precautions And Maintenance Instructions:

1. Never runs the apparatus if power supply is less than 180 volts and above than 230 volts.

2. Never switch ON mains power supply before ensuring that all the ON/OFF switches given on the panel are at OFF position.

3. Operates selector switches of temperature indicator gently.

4. Always keep the apparatus free from dust.

11. Troubleshooting:

1. If electrical panel is not showing the input on the mains light, checks the mains supply.

2. If Voltmeter shows the voltage given to heater but ampere meter does not, ckeck the connection of heater in control panel.

12. References:

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